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ABSTRACT

This paper examines the current status of technology in schools in developed countries and in developing countries such as South Africa. It identifies strategies used by principals in underresourced schools to cope with increasing demands regarding the integration of technology into the curriculum, proposing management strategies for putting schools in developing countries in the global arena with regard to technology use. While South Africa was the 14th most wired country in the world in 1997, fewer than 1 percent of its schools have Internet access. A survey of 52 school principals examined the number of computers available for administration, teaching, and learning, how those computers were used, and how much training teachers received. Less than half of the schools had computers for administrative purposes, and most had no computers for teaching and learning. Principals considered access to computers by learners very important and were frustrated by being behind the rest of the developing world. Principals reported trying unsuccessfully to establish partnerships with the private sector. The paper recommends that the process of integrating computers into schools in developing countries be managed at all levels (administrator, teacher, student, and teaching/learning). (Contains 36 references.) (SM)

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# MANAGING CHALLENGES TO THE INTEGRATION OF TECHNOLOGY INTO SCHOOLS IN A DEVELOPING COUNTRY: A SOUTH AFRICAN PERSPECTIVE

**Elsa Mentz** (Senior lecturer, Subject group Computer Science, Faculty of Education Sciences, Potchefstroom University, South Africa)

and

**Kobus Mentz** (Associate professor in Educational Management, Faculty of Education Sciences, Potchefstroom University, South Africa)

Contact information of lead author:

**Elsa Mentz**
Faculty of Education Sciences
Potchefstroom University
Private Bag X6001
Potchefstroom
2520
South Africa

e-mail: pokem@puknet.puk.ac.za
Fax: +27-18-2991755

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**Introduction**

It is estimated that more than 60% of jobs in the information age will require some level of technical competency and that the demand for IT specialists worldwide is set to grow faster than training institutions can produce people with the requisite skills (Business Day, 2001). It is not necessary to spell out the implications of the aforementioned fact for training institutions such as schools. Schools are expected to equip learners with the basic technological skills required by society. With the pressure being put on schools to perform in the field of technology came the demand for leadership to facilitate this process. The TTL Academy for School Administrators at the University of South Dakota (TTL SA, 2002) states that education in the Information age requires that school administrators not only update their skills and knowledge, but that they also work towards the transformation of their roles as educational leaders. One of the key issues that the Academy focuses on is assisting administrators with planning, budgeting and implementation of a school-wide technology program, including a professional development program.

It is clear that the introduction into and improvement of technology in any organization, including schools, requires leadership. This paper deals with the challenges of the introduction of technology into schools in a developing country, and the associated leadership challenges that this introduction poses. In this process, questions arise about the role of teacher training in ensuring the effective introduction of technology into schools, as well as obstacles in the way of achieving success regarding technology in schools. It is clear that the aforementioned places a heavy burden on school management to ensure that the processes involving computers in schools are managed effectively. In the absence of resources it becomes an ever-greater challenge, as will be indicated in this paper. In this paper, the focus is on computer technology as the current focal point in the integration of technology into schools.

Cognizance is also taken of the fact that, especially in developed countries, critique is being voiced about the negative impact that technology in schools can have on effective teaching and learning. Kearsley (1998: 47) encourages the educational technology community to start think of a different perspective and approach to technology in education. He goes as far as to say that educational technology is primarily, if ironically, a distraction (on a grand scale) from what matters most – effective learning and good teaching. Obviously, these statements were made from a Western, developed, perspective. Developing countries, however, need to take part in this debate, in order to avoid the pitfalls.

Whilst strategies in developed countries are being implemented effectively in order to equip schools for the demands of a technological society, the situation in schools in developing countries is quite different. Mentz (2000: 277) found that more emphasis need to be placed on the training of learners as well as educators in information technology in a developing country such as South Africa. Wilkinson & Strauss (1998: 257) say that there is urgency in the need for redress in the area of technology in schools and that creativity, leadership and commitment are needed to achieve this. They are of the opinion that the South African education system is fundamentally flawed by inequities, imbalances and distortions resulting from its history, present structure and the ineffective management of schools.

The question that arises is then how to effectively develop a strategy for the successful management of technology for purposes of teaching and learning in under-resourced schools in developing countries (such as South Africa) in order to

deal with the requirements of the technological society. In an African context South Africa can be considered one of the more developed countries. However, a strategy that is successfully implemented in South Africa could serve as a model for many developing countries. In this regard, the Conference of Commonwealth Education Ministers, representing a large number of developing countries, agreed that the process of integrating information technology into education should be speeded up (CCEM, 2000: 31). It is clear that the focus in the development of any strategy should be on the enhancement of the capacity of school administrators, and especially school principals, in order to lead the way in implementing technology into the school curriculum in an integrated manner. The Report of the Task Team on Education Management Development (Department of Education, 1996) found that computer hardware and software and other technologies that underpin modern management are only very disparately available to school management in South Africa. If the management actions of the school principal are not supported by technology, he/she will clearly not be in a position to exercise leadership in the implementation of technology in the classroom. On a more positive note, it was stated in 1999 that " ...information technology is gradually becoming affordable as costs come down and should be aggressively harnessed to support teaching and learning in schools...' (Department of Education, 1999: 65).

Objectives of the research

With the above-mentioned serving as the framework in which research on technology and leadership in a developing country takes place, the objectives of this paper are the following:

- to establish the current status of technology in schools in developed countries, as well as in a developing country such as South Africa;
- to identify existing strategies followed by school principals in under-resourced schools in order to cope with the increasing demands on the integration of technology into the curriculum; and
- to propose innovative management strategies in order to put schools in developing countries in the global arena with regard to the use of technology.

**Curricular and managerial issues pertaining to the research**

From the above it is clear that there are curricular and managerial issues to be addressed when investigating the management of the integration of technology into schools. Certain assumptions underlying this study will now be made, indicating the conceptual framework used.

Outcomes-based education (as implemented in South Africa) is strongly related to competency-based education. Application of knowledge and the transfer of knowledge and skills related to communication, problem solving, use of information, analysis and decision-making are simultaneously part of the conceptual foundation of competency-based and outcomes-based education (cf. Malan, 1999; Everwijn, Bomers & Knubben, 1993). Technology is described as follows:

- a specific type of knowledge used to solve practical problems (Microsoft, 1999)
- the application of scientific and other knowledge to practical tasks by organizations that involve people and machines (Naughton, 1994:12)
- the generation of knowledge and processes in order to develop systems to solve problems and broaden human abilities (ITEA, 1997).

Computer technology is viewed in the literature as a component of technology (cf. Computeruser, 2000; CMPnet, 2000). Chen (1999) is of the opinion that computer technology has emerged as important to all industry sectors. Ellis (1993:69) views computer technology in schools as an important tool in order to assist the teacher in preparing lectures, developing learning material, assessing learner performance, teaching concepts such as simulation, fostering mathematical and scientific skills and improving communication skills.

**Technology in schools in developed countries**

The International Society for Technology in Education (ISTE, 1998a: 1) identified the following three reasons for teaching of technology at school level:

- parents demand it, in order for their children to be prepared for the world of work or for tertiary education;
- employers demand it, because they prefer employees who are technologically literate; and
- society demands it, because technologically literate citizens can make an effective contribution towards society.

Although the ISTE is an international society, it is evident from the different standards that it has developed that it focuses on developed countries. The ISTE (1998a: 5-6) developed technology standards that should be applicable to all learners. These standards have been adopted by several developed countries such as the USA, the United Kingdom and Australia.

The ISTE (1998b) also established standards for the training in technology of pre-service teachers.

It is clear that teaching at school level and the training of teachers are the two aspects that are of critical importance when looking at the introduction of technology into schools. Developing countries (see below) need to focus on these two areas when implementing strategies to manage the process.

In the United States, the programs of the ISTE are accredited by the National Council for the Accreditation of Teacher Education (NCATE). In adopting the standards of the ISTE (1998a:4), the NCATE clearly distinguished between the following:

- standards for computer technology,
- standards for technology in education and
- standards for technology education.

In order to be accredited by the NCATE, programs for initial teacher training in the USA should include, amongst others, basic computer and technology concepts, personal and professional use of technology and applications for technology in education (ISTE, 1998c). O'Donnell Dooling (1999:1) views the 1997 Presidential report on the use of technology in K-12 education in the USA as groundbreaking, because it was recommended that computer technology play a central role in teaching and learning in future.

O'Donnell Dooling (1999:16,22) further recommend the following:

- that teachers consider involving other learners, parents or members of the community when teaching technology,
- that teachers strive towards the more effective integration of computer technology into the whole school curriculum and
- that the continued training of teachers receives urgent attention.

Taking a step further, Adams and Jansen (1997:1) argue the case for a paperless classroom. Despite the improvement of the use of technology in classrooms in the USA, the authors criticize the limited use of this technology in order to improve teaching and learning.

In The United Kingdom the National Curriculum (Department for Education, 1995), divide technology into separate subjects, namely *Design and Technology* and *Information Technology*. In the subject *Information Technology*, learners must use information sources, and specifically IT resources, to solve problems, they must use IT resources to support their learning in different contexts and they must know what the impact of IT in the workplace and community is.

The Australian Council for Computers in Education (ACCE, 2000a) launched a project: *Teacher Learning Competencies*. The purpose of this project is to improve the knowledge, skills and attitudes of teachers regarding the integration of technology into the curriculum. Certain minimum standards for the technology training of teachers have been laid down in Queensland (ACCE, 2000b). These standards have been categorized into the following:

- Information technology skills
- Curriculum applications, including classroom management and planning
- School-wide planning
- Learner-centered instruction

When comparing the efforts of developed countries to deal with the increasing demand for integrating technology into the curriculum and schools, it is clear that there is still conceptual as well as managerial confusion around the role of technology in schools. On the IFETS Discussion List on 11 April 2001 (http://www.ifets.ieee.org/discussion/discuss.html) Brent Muirhead from the University of Phoenix commented as follows on the aspects of management and the training of teachers:

> *Today, integrating technology into the curriculum is failing because teacher training is the missing ingredient in educational reform efforts. I have observed how metro Atlanta, Georgia public school districts have created a flawed educational system. Sadly, the current administrative structure fails to adequately prepare teachers to effectively use their computers and computer labs. Often, the technology staff devotes most of their time to repairing computers. In fact, my school system has state of the art equipment: all buildings are wired for computers and cable televisions, a network system that continues to add more sophisticated software packages and the financial resources to provide live television shows between schools. Yet, the absence of consistent technology instruction for teachers has created an unnecessary barrier to creating relevant technology applications. Unfortunately, students are given the illusion of computer-mediated instruction. I have noticed that teachers are trying to compensate for the lack of professional instruction by helping each*

*other learn new software programs. Ultimately, school districts are going to have to invest more money and personnel into training their teachers. The American public has high expectations for their teachers. Yet, they are often not willing to provide the basic resources for them to effectively do their jobs.*

It is clear that the answer to the question on how to effectively introduce technology into schools lies not (only) in the provision of more money. Effectively managing the process and ensuring that teachers are trained to meet the new challenges, are key aspects in developed countries. This is also the case in developing countries, as will be shown.

**Technology in schools in a developing country**

South Africa was in 1997 the 14th most wired country in the world, yet fewer than one percent of its schools have internet access. According to the Harvard Network Readiness Index (Badenhorst, 2002: 60) South Africa is in the 40th place out of 75 countries that were involved in the research. The Network Readiness Index (NRI) indicates the extent to which countries are prepared to meet the challenges posed by improved technology. It also indicates the potential of countries to participate in an integrated global economy. Not surprisingly, the USA topped the list in terms of network readiness, followed by Iceland, Finland, Sweden and Norway. A clear division between developed and developing countries is found in the list, with countries such as Egypt (60th), Zimbabwe (70th) and Nigeria (75th) at the bottom of the list.

The Department of Education of South Africa (1998:22) reported that 82% of all schools in the country does not have any educational media at all. Therefore, a large number of learners in the country do not receive any training in basic computer technology. When considering the fact that more than 85 000 teachers in the country are regarded as unqualified or underqualified (ETDP, 2000), the situation worsens. Without doubt, qualified teachers are the catalysts in the introduction of technology in any school. Mentz (2000: 5) identifies the lack of trained teachers as one of the main obstacles in the way of effectively introducing technology into schools in South Africa.

Haupt & Mintoor (1997) established that 80% of learners in South Africa leave school without once being exposed to a computer. They view the first step in rectifying this process as the introduction, on a larger scale, of technology training for teachers. They are further of the opinion that the following critical aspects need to be addressed before technology can effectively be introduced into schools in South Africa:

- improving the computer skills of teachers
- enhancing teacher's ability to use the computer as a tool in problem solving
- making technology available in schools

In this regard, Mentz (2000: 6) view the need as twofold: On the one hand, there is a subject-based need in the sense that teachers need to be equipped with knowledge of the effective teaching of their subject while integrating technology into teaching

and learning. The second need, closely linked to the first one, is the one for equipping teachers with the technological skills needed to function in the information age. Plumstead (Futurekids, 1999) asks for the training of teachers in technological skills as a prerequisite for the transition of South Africa into a developed country. He singles out the introduction of technology for purposes of school management, teaching preparation and internal communication as the most important fields of application. Chiles (1997:2) is of the opinion that two factors, namely the lack of training in technology skills and changing employer attitudes, emphasize the necessity of introducing computers at a faster pace into schools in South Africa. Although the cost factor is usually used as an excuse for not introducing technology into schools, Holman (1998:1) points out that the introduction of computers and relevant software may be a cost-effective solution. The process of distributing textbooks to schools in remote areas and the administration of a system of providing free textbooks to all is a costly one. The information age demands as little delay as possible in the provision of textbooks.

It is important to distinguish between the concepts *technology*, *computers in education* and *computer technology education* when arguing the case for technology in schools. Mentz (2000:152) holds the view that computer technology education is needed in South African schools and defines the concept as follows:

> *Computer technology education implies knowledge of a computer, including the development of, nature of, underlying principles of and conceptual clarity about a computer. It also means an understanding of the processes associated with computer technology as well as the effective use of information systems relevant to any given task.*

In 1998 a new system of education was introduced in schools in South Africa, called Curriculum 2005. Although it is called a new system, it actually implies moving towards the instructional method known as outcomes-based education. Eight learning areas were introduced into schools, including Technology. As early as 1992, Eisenberg (1992) developed a curriculum framework for technology education as part of a science and technology education project in South Africa. He refers to information technology (including the computer) as part of Technology. This framework was used to an extent in developing the outcomes for Technology for Curriculum 2005. The emphasis, however, is largely on systems and control, communication, and structures and processes not directly linked to computer technology (Department of Education, 1998). It can be assumed that the absence of computers in most South African schools was the reason for downplaying the role of computers in the learning area Technology. Such a pragmatic stance is, however, not in the long-term interest of the country, or for that reason, any developing country. In 2002 the Ministers of Education and Communication announced in a joint statement (http://education.pwv.gov.za/teli2/ICT) that the question is not *whether* computer technology should be fully introduced in teaching and learning, but *how* it should be introduced. As a short-term strategy all schools would be provided with at least one computer for administration and support services. Satellite technology and solar power would be used where schools do not have electricity. Steps that were taken after the announcement clearly indicated the sincerity of the government regarding computer technology in schools. The Ministers stated that the following scenario should be avoided at all costs:

> "Technology is often implanted into education communities with little thought given to the consequences. The computers arrive, installation is completed, the ribbon is cut and the door is closed".

In 1996 the task team on Educational Management Development (Department of Education, 1996:68) found that, in order to perform adequately within the context set by national policy and legislation, all school management structures would require "... appropriate information technology." The areas of school management, training of teachers and technology are inextricably linked in the South African context.

**Introduction of technology into schools: Results of the survey**

A telephone survey was conducted, involving 52 principals of schools representing 26 417 learners. A random sample of 49 schools from the Potchefstroom district in the North West Province of South Africa was selected to participate in the survey. Questions pertaining to the number of computers available for administrative purposes and for purposes of teaching and learning were asked, as well as the way in which these computers were used. A question relating to the level of training of the educator responsible for implementing computers for teaching and learning was also asked. Principals were then asked to rate the importance of access to computers by learners on a scale of 1 to 5. Finally, two open-ended questions were asked. Principals were requested to discuss the important obstacles preventing the successful implementation of technology in schools. They were then requested to suggest strategies in order to speed up the effective implementation of technology in schools.

It was found that only 46% of schools had computers in schools for administrative purposes, while 81% had no computers for purposes of teaching and learning. In the majority of schools where computers were used for teaching and learning, principals were of the opinion that they were used effectively and that the educators responsible for computer training were well trained.

Principals were also asked to rate the importance of access to computers by learners. Although the majority of schools had no access to computers, 88% of principals viewed access to computers by learners as *very important* (5 on a scale of 1 to 5). An average of 4,79 out of 5 was obtained for this question.

In the first of two open-ended questions, principals were asked to give their personal opinion about the obstacles that prevent the effective use of computers in schools in South Africa. The responses were analyzed by grouping them into categories. These obstacles are the following, in order of importance:

- Insufficient financial support by the Department of Education
- Untrained teachers
- Lack of electricity
- Socio-economic status of the community
- Insufficient security and the resulting vandalism and theft
- Curriculum constraints ("where do we fit computer education into an already tight curriculum")
- Unfavourable teacher:learner ratio (usually more than 1:30)
- Lack of classrooms suitable to serve as computer labs

It became evident that principals are frustrated because they seem unable to manage their schools in order to be in line with developments in the real world. One principal reported:

"Many of our learners have never in their lives seen a computer ."

Another principal from a rural school reported that the Department of Education "..has forgotten about us rural schools."

Some schools, especially those in affluent areas, are able to raise funds from the parents and community for the introduction of computers into schools. Unfortunately, the schools in poor communities are also those schools exposed to vandalism and theft, once they have succeeded in obtaining computers for their schools.

Through the last question, principals were asked to suggest management strategies in order to speed up the implementation of technology in schools. The majority of answers belonged to the following categories:

- Financial support by the Department of Education (although many principals expressed doubts as to whether the Department has the necessary resources)
- Partnerships between schools and the private sector
- Training of teachers in computer technology
- Training of parents in computer technology

Many principals reported that they have unsuccessfully tried to establish partnerships with the private sector.

In reviewing the open-ended answers, it became clear that certain levels of computer use in schools could be identified. Schools without the necessary capacity only introduced computers at the administrative level. Others had the opportunity to move to the level of teachers achieving the required computer skills, and a minority was able to achieve learner literacy and the full integration of computers into the teaching and learning process. It seems that, as resources are made available and managerial skills are sharpened, schools move through different levels of technological preparedness. These levels are the following:

**Level 1: The implementation of computers in the administration of the school**

**Level 2: Teachers acquiring basic computer skills**

**Level 3: Learners acquiring basic computer skills**

**Level 4: Integrating computers into teaching and learning**

In recognizing that schools introduce computers step-wise as indicated above, it is necessary to manage the process accordingly.

**Managing a process of integrating computers into schools**

From the aforementioned it is clear that the process of integrating computers into schools in a developing country should be managed at all the above-mentioned levels. Both departments of education and school management are involved at all the levels, although the nature of the involvement differs across the four levels.

Regarding level 1, departments of education should realize that even providing one computer per school could eventually be cost-effective. Linking schools through a network and communicating via e-mail can save on the current high mail and transport costs. Examples exist of how to use a computer in a school without electricity by using a 12-volt battery and satellite technology. Providing textbooks electronically (not disregarding copyright legislation) and allowing schools to print the materials as required can be especially cost-effective, as the provision of textbooks through other measures is not cost-effective, especially in rural areas. The South African minister of education (http://education.pwv.gov.za/teli2/ICT) declared that it is committed to install at least one Internet-linked computer for administration and support purposes in all schools. Regarding school management, its duty is to support staff in acquiring the necessary skills to implement a computer-based

administrative system in the school. The necessity of inspiring staff and creating a culture of acceptance of technology as part of the school administration should be nurtured. According to the South African Schools Act, governing bodies of schools should explore alternative ways of generating funds for the school. Whilst it can be seen as the duty of the department of education to **provide** technology, the **maintenance** thereof should be the responsibility of the school, thereby nurturing a culture of ownership. In this process the application of sound marketing principles in order to liaise with the private sector should be managed effectively by school management.

The training of teachers (cf. Level 2) has been identified as one of the key challenges and priorities in South Africa (Department of Education, 1999: 60). In managing the process of introducing technology into schools, this commitment should be extended to empower teachers in order to function as computer literate in a society that demands the knowledge and skills associated with technology. In terms of concrete outcomes, the Minister of Education announced that all educators and learners should have basic competence in the use of word processing, spreadsheet, database, e-mail and web browser applications (http://education.pwv.gov.za/teli2/ICT). Any department of education has as one of its duties ensuring that teachers are professionally trained and prepared to meet the challenges that teaching and learning pose. Co-operation between departments and tertiary institutions should be fostered, as well as the provision of courses to teachers to ensure that they acquire basic computer skills. At the second level, the school also has an important part to play. The school management should again create an environment conducive to the new culture brought about by exposing teachers to technology. Throughout the process it is necessary to ensure that the learners benefit optimally by the teachers becoming computer skilled. Networking among teachers and co-operative learning whereby teachers share their newly gained knowledge with each other is vital to the process.

Once the first two levels have been successfully reached, schools can begin to take on their professional role and ensure that learners become computer literate (Level 3). The revision committee of Curriculum 2005 (Department of Education, 2000) strongly suggests that schools should expose learners to technology *once teachers have been made technology-literate and the necessary facilities have been provided.* Again, the responsibility for achieving this should be shared by the department of education and school management. School management in ensuring that computers are used optimally and that the school timetable provides for the introduction of technology must follow the curriculum resources and infrastructure provided by the department of education. The importance of motivation of learners by teachers and principals alike should not be underestimated. Emphasizing to learners the importance of acquiring computer skills can make the difference between the successful or the failed introduction of technology.

The fourth level requires a commitment from teachers to investigate how computers can successfully be incorporated in their curriculums. Networking with other teachers is essential to ensure quality and, to a certain extent, uniformity. From the literature survey and the questionnaires that were implemented, it became clear that the integration of computers into teaching and learning is lagging behind. It can be assumed that this problem exists in most developing countries. There is an urgency to ensure that the computer is being used in schools for administrative purposes and that teachers and learners become computer literate. When looking at developed countries, it is clear that the integration process is being researched and that implementation is taking place.

It can safely be assumed that the management of the integration process will (and should) be done primarily at the school level. In this process, the school principal will play a vital role. Keeping in mind that the average principal lacks the infrastructure and finances to implement effective strategies for the integration of technology in schools, the principal has a dual role to play. On the one hand, the principal should be involved in forging partnerships between the private sector and schools. It was evident from the survey (as reported above) that principals see themselves as fulfilling the role of mediator with the private sector. On the other hand, the principal is also managing the teaching process in the school. The full integration of technology into schools requires from principals to be flexible with regard to teacher initiatives. Thinking afresh and experimenting with technology in the different subjects and learning areas will be part of the process. Outdated leadership approaches by principals in order to ensure that they control the teaching learning process in the school will fail to create winning schools.

Recent research on the role of the South African manager in general indicated that South Africa rated 46th out of 47 countries in terms of the extent to which the societal values of hard work and innovation support competitiveness (Coetsee, 2001:83). It is not difficult to prove that a society moving towards the integration of technology into society (and schools) needs to be competitive. It can safely be assumed that education is one of the key factors ensuring that a country become competitive. Without resources, it is the task of the principal to create a motivational climate (cf. Coetsee, 2001:210) wherein the changes to be brought about by technology can be managed. If the integration of technology into schools is managed successfully, any developing country will reap the benefit not only locally, but also in becoming an integral part of the global economy.

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